Candidate Name	Class	Register Number

CHANGKAT CHANGI SECONDARY SCHOOL

Mid Year Examination 2010

Subject	**:**	**Science (Physics)**
Paper No	**:**	**5116/02 / 5117/02**
Level	**:**	**Secondary 3 Express**
Date	**:**	**12 May 2010**
Duration	**:**	**1 hour 15 minutes**
Setter	**:**	**Hong Kam Kheun**

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.
Write your name, class and register number in the spaces at the top of this page.

Answer **all** questions in Section A and any **two** questions in Section B.
In calculations, you should show all the steps in your working, giving your answer at each stage.
Enter the numbers of the Section B questions you have answered in the grid below.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiners' Use	**Marks**
Section A	/ 45
Section B	
	/ 10
	/ 10
Total	/ 65
Expected Grade	Actual Grade
Parent's / Guardian's signature	

This Question Paper consists of **11** printed pages.

[Turn over

Section A [45 marks]

Answer **all** the questions in the spaces provided.

1. A cube of volume 0.080 m^3 and made of a material of density 200 kg/m^3 was brought to the Moon. The value of gravitational field strength, *g*, is 10 N/kg on Earth and 1.5 N/kg on the Moon.

Calculate

(a) the mass of the cube on the Moon, [2]

Mass, m = density x volume = 200 kg/m^3 x 0.080 m^3, [1]
= 16.0 kg [1]

(b) the weight of the cube on the Moon, [1]

Weight, W = mg = 16.0 kg x 1.5 N/kg = 24 N [1]

(c) Given that the density of water is 1000 kg/m^3, will this cube sink or float in water? Support your answer with a reason. [2]

It will float. [1]
The density of the cube is less than the density of water [1].

2. A block of weight 200 N is pulled to the right across a level ground with a horizontal force of 50 N. The constant frictional force acting on the block is 15 N. The gravitational field strength, *g*, of Earth is 10 N/kg.

(a) State the contact force exerted by the ground on the block. [1]

Contact force = 200 N

(b) Fig. 2 is a free-body diagram of the block. Draw and label in Fig.2 all the forces acting on the block. [2]

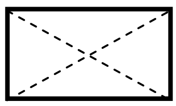


Fig.2

[1] for the set of horizontal forces, [1] for set of vertical forces.
If all forces drawn but not at CG, then [1]

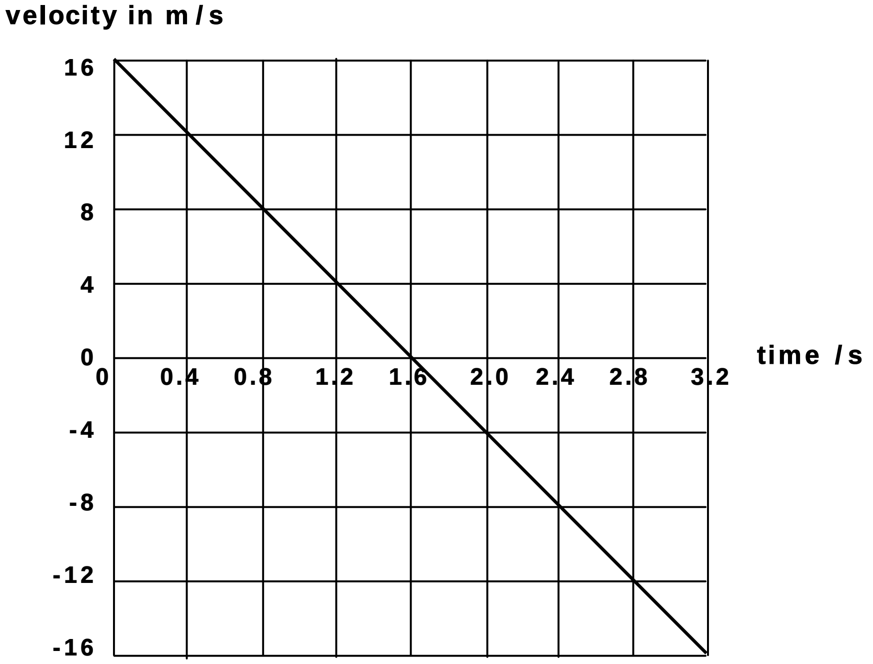
(c) Calculate the resultant force on the block. [2]

Resultant force, F = 50 N + (-15 N) [1]
= 35 N [1]

(d) Calculate the resultant acceleration of the block. [1]

Resultant acceleration, a = F/m = 35 N / 20 kg = 1.75 m/s^2 [1]

3. The graph below shows how the velocity of a stone varies from the moment it is thrown vertically upwards into the air.



(a) At what time did the stone reach the highest point? [1]

At t = 1.6 s [1]

(b) Explain what is happening to the stone when its velocity is negative. [1]

When its velocity is negative, it means the stone is moving or falling downwards. [1]

(c) Calculate

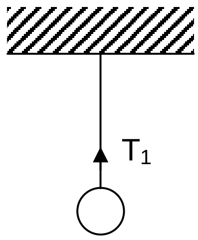
(i) the acceleration of the stone, and [2]

Acceleration, a = (v-u) / t = (0 – 16) / 1.6 [1]
= - 10 m/ s^2 [1]

(ii) the maximum height travelled by the stone measured from the point of release. [2]

Maximum height = distance travelled in 1.6s = area under the graph
= ½ x 16 x 1.6 [1]
= 12.8 m [1]

4. The diagram below shows a steel sphere of weight 4.0 N suspended from a point in the ceiling.



(a) **(i)** State the resultant force acting on the steel sphere. [1]

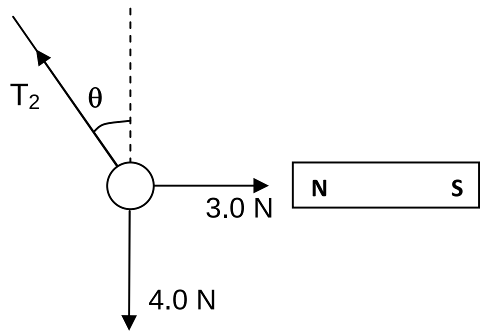
Resultant force = 0

(ii) Calculate the tension T_1 in the string. [1]

Resultant force = tension T_1 + (- weight W)

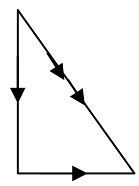
0 = T_1 – W ➔ T_1 = W = 4.0 N [1]

(b) A powerful magnet is brought near the sphere and it attracts the sphere with a force of 3.0 N such that the string makes an angle of θ with the vertical as shown below.



(i) Using a scale drawing, determine the magnitude of the resultant force of the 3.0 N and 4.0 N forces. Take the scale to be 1 cm:1 N. [3]

[1] for correct triangle.
[1] for arrows indicated corrected.

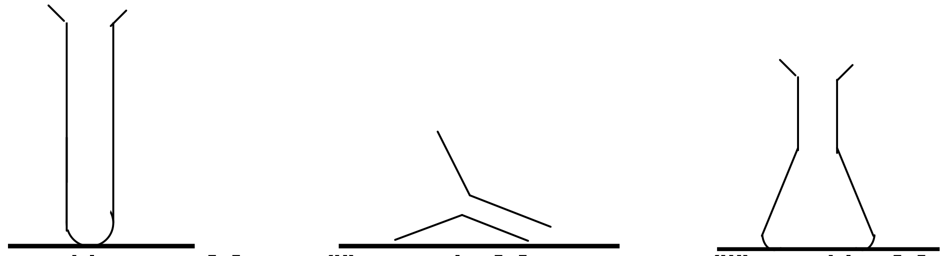


Magnitude of resultant force = **<u>5 N [1]</u>**

(ii) Hence, state the magnitude of the tension T_2 in the string. [1]

Magnitude of the tension T_2 = **<u>5 N [1]</u>**

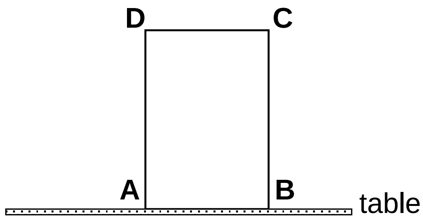
5. **(a)** Identify the state of equilibrium for each of the given apparatus below. [3]



(i) unstable **[1]** **(ii) neutral** **[1]** **(iii) stable** **[1]**

(b) The diagram below shows side AB of a uniform block of wood resting on a table.

Fig. 5.1



(i) Mark and label the centre of gravity (G) of the block on Fig. 5.1, showing all the necessary construction lines. [1]

[1] for intersection of the 2 diagonals.

(ii) In Fig. 5.2, the block is then pushed so that it begins to tilt about the edge at B.

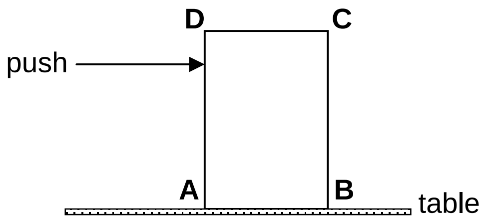
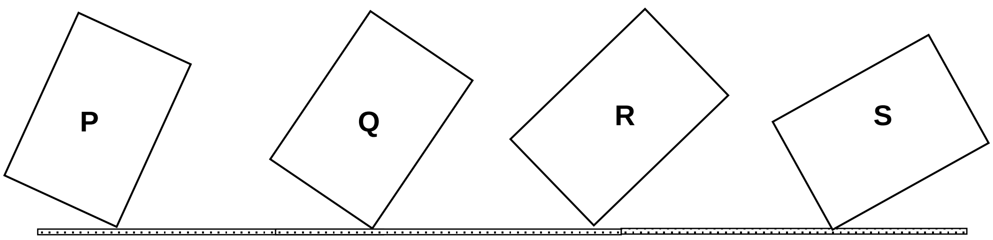


Fig. 5.2

Circle the diagram in Fig. 5.3 that shows the tilting of the block just before it falls over. [1]

Fig. 5.3



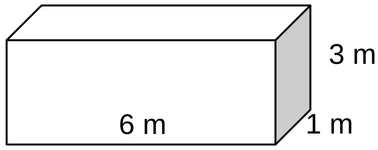
Give a reason for your choice of answer. [1]

Tilting at Q is just before the block falls over as the line of action of the weight is just outside the base of the block OR the moment of the weight is clockwise and topples it.

6. **(a)** An Eskimo stands on snow wearing snow-shoes. The mass of the Eskimo is 40 kg and the snow-shoes have a total area of 0.5 m^2 in contact with the snow. Taking the gravitational field strength, g, to be 10 N/kg, calculate the pressure exerted by the Eskimo on the snow. [2]

Pressure, p = F/A = (40 x 10) / 0.5 [1]
= 800 Pa [1]

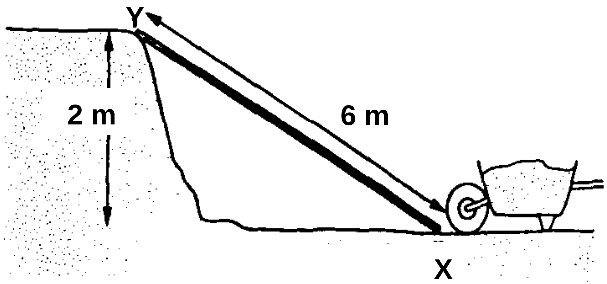
(b) A rectangular block of weight 9000 N, has the following dimensions of 1 m by 3 m by 6 m, resting on one of its sides.



Calculate the greatest pressure it can exert on a flat surface. [2]

For greatest pressure, area of resting face is smallest, i.e. A = 1 x 3 = 3 m^2
Greatest pressure, P = 9000 N / 3 m^2 [1]
= 3000 Pa [1]

7. A gardener uses a plank to move soil weighing 300 N in a wheelbarrow from point X to point Y. He took 3 seconds to push the wheelbarrow from X to Y.



(a) Calculate

(i) the work done in moving the soil of 300 N from X to Y [2]

Work done, W = F x d = 300 N x 2 m [1]
= 600 J [1]

(ii) the power generated by the gardener between X and Y. [2]

Power, P = W/t = 600 J / 3 s [1]
= 200 W [1]

(b) **(i)** On reaching point Y, the bag of soil slipped off and fell to the ground. Calculate the speed of the bag of soil just before hitting the ground. [2]

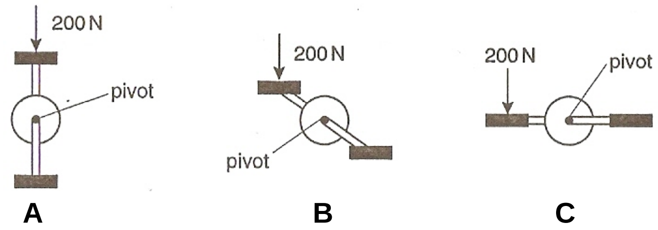
Ke of bag before hitting ground = 600 [1]
½ (30) v^2 = 600 ➔ v^2 = 40 ➔ v = 6.32 m/s [1]

(ii) State what happens to the energy of the bag after hitting the ground. [1]

Kinetic energy changes to heat energy and sound energy [1]

8. **(a)** Fig 8.1 shows the same vertical force of 200 N exerted by a cyclist on the pedal of a bicycle in three different positions, A, B and C.

Fig 8.1



State which of the positions **A**, **B**, or **C**, in which the force exerts:

(i) the largest moment about the pivot, and [1]
Position **C [1]**

(ii) the smallest moment about the pivot. [1]
Position **A [1]**

(b) Fig 8.2 shows a support for a leg in plaster and Fig 8.3 shows a simplified diagram of the forces acting on the leg.

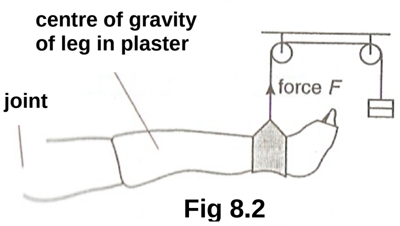


Fig 8.2

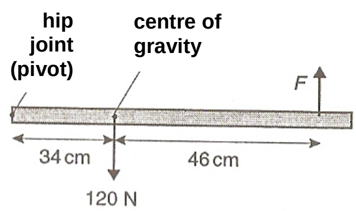


Fig 8.3

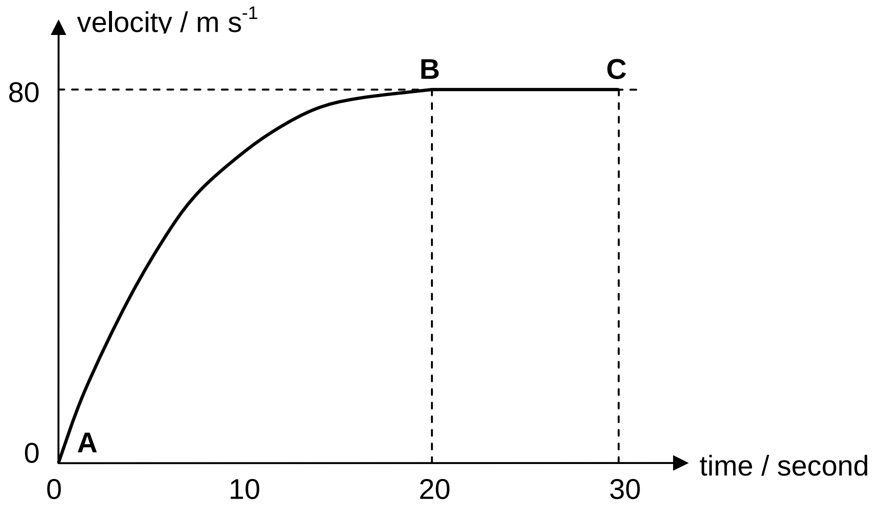
Calculate the force F needed to keep the leg in a horizontal position. [3]

For equilibrium,
anticlockwise moments = clockwise moments [1]
F x 80 cm = 120 N x 34 cm [1]
F = 51 N [1]

Section B [20 MARKS]

Answer any **two** questions from this section in the space provided.

9. A drag car of mass 1500 kg is being tested on a straight road. The car engine provides a constant driving force of 15000 N throughout the motion of the car. In a particular test-run, its velocity-time graph is shown in the diagram below.



(a) At the beginning of the test-run, the car accelerates at a rate of 9 m/s^2. Calculate the total resistance experienced by the car. [2]

Let the resistance be R.
Resultant force, F = ma ➔ (15000 – R) = 1500 x 9 [1]
R = 1500 N [1]

(b) (i) Describe the acceleration of the car as it moves between point A and point B. [1]

Acceleration decreases to zero [1]

(ii) Explain why the acceleration between points A and B is as given in the graph. [2]

This is due to the increasing resistance [1] on the car as it moves faster, which causes the resultant force and the acceleration to decrease [1].

(c) State the magnitude of the acceleration of the car between points B and C. [1]

Acceleration = **zero [1]**

(d) Calculate the total resistive forces acting on the car between points B and C. [1]

15000 – R = 0
R = 15000 N [1]

(e) At the end of the 30s, the engine is switched off and a parachute opened up at the back of the car. This provided a constant braking force on the car causing it to come to a complete stop after travelling 100m. [3]
Calculate the total resistance experienced by the car.
Distance = ½ x 80 x t = 100 ➔ t = 2.5 s [1]
Acceleration, a = (0 – 80) / 2.5 = 32 m/s2 [1]
Total resistance, T = ma = 1500 x 32 = 48000 N [1]

10. Fig. 10 shows an empty wheelbarrow which weighs 50 N. A worker pulls upwards on the handles with a force of 10 N to keep the handles horizontal. The point marked M is the centre of mass of the wheel barrow.

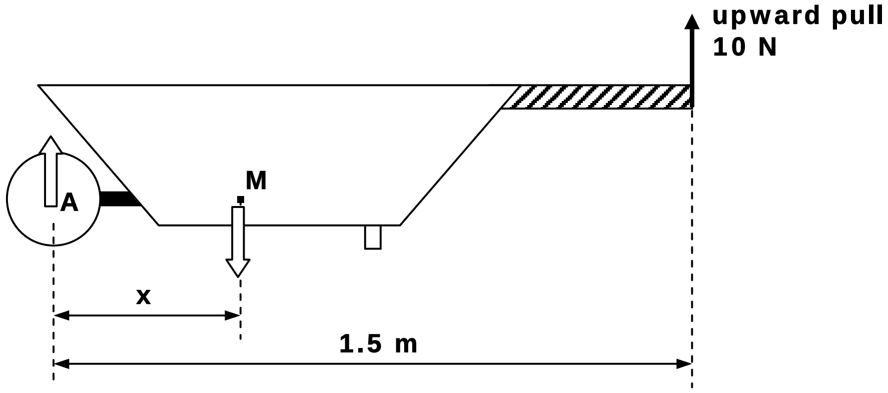


Fig. 10

(a) On the diagram given in Fig. 10, draw arrows to show where the other two vertical forces act on the wheelbarrow. [2]

At A [1] and at M (centre of gravity) [1].

(b) Determine

(i) the moment of the 10 N force about the centre of the wheel A. [1]

Moment = 10 N x 1.5 m = 15 N m [1]

(ii) the distance, **x,** between points A and M. [2]

50 N x x = 15 N m [1]

x = 15 N m / 50 N = 0.30 m [1]

(c) Given that the maximum upward pull that can be exerted by the worker is 1000 N, determine

(i) the maximum load on the wheelbarrow that he is able to lift, assuming the centre of gravity of the maximum load is at point M, and [2]

Let the load be L.

L x 0.30 m = 1000 N x 1.5 m [1]

L = 1000 N x (1.5 / 0.30) = 5000 N [1]

Maximum load = 5000 N – 50 N = 4950 N (accept 5000 N as answer)

(ii) the magnitude of the force acting on the wheel [1]

Let the force be W

Total upward forces = total downward forces

W + 1000 N = 5000 N ➔ W = 4000 N [1]

(d) Suggest two modifications to the wheel barrow to allow the same worker to carry a heavier load. [2]

(i) **use a longer handle bar**

(ii) **designed such that the centre of gravity of load is closer to the wheel**

11. A falling metal hammer is used to drive a hollow steel post into the ground, as shown in Fig. 11. The hammer is lifted by an electric motor and it is then released such that it falls freely to hit the baseplate.

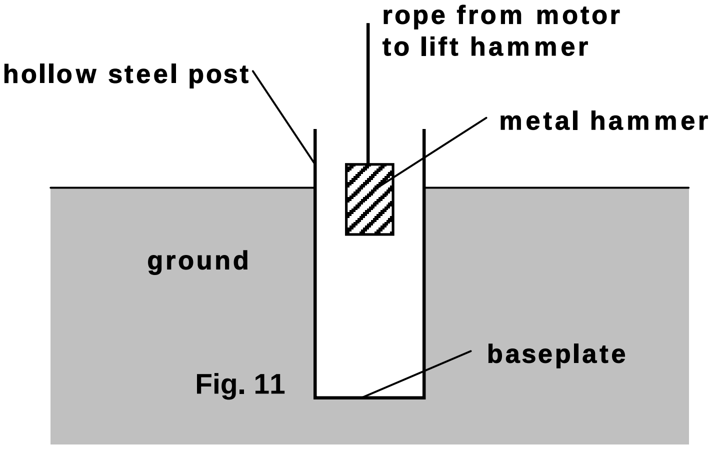


Fig. 11

(a) **(i)** State the law of conservation of energy. [1]

The law of conservation of energy states that energy cannot be created or destroyed but it only changes from one form to another.

(ii) State the energy conversions that take place when the hammer is released until it hits the baseplate. [2]

(Gravitational) potential energy → kinetic energy → sound & heat energy [all 4 energies → 2 m]

(b) The hammer has a mass of 1200 kg and it hits the baseplate with a speed of 5 m/s.

(i) Calculate the kinetic energy of the hammer as it hits the baseplate. [2]

k.e. = $\frac{1}{2}$ m v^2 = $\frac{1}{2}$ (1200)(5^2) [1]

=15000 J [1]

(ii) State the initial potential energy of the hammer. [1]

Initial potential energy = final k.e. = 15000 J [1]

(iii) Assuming that there is no energy loss through frictional forces, calculate the height above the baseplate from which the hammer is dropped. Take the gravitational field strength, *g* as 10 N/kg. [2]

Loss of p.e. = gain in ke ➔ mgh = 15000

Height, h = 15000 / (1200)(10) = 5/4 = 1.25 m

(c) The hollow steel pipe moved 0.005 m into the ground as a result of the impact on the baseplate. Calculate the average resistive force of the ground acting on the pipe. [2]

Let the average resistive force be R.

Work done against R = loss of k.e. [1]

R x 0.005 m = 15000 ➔ R = 15000 / 0.005 = 3000000 N [1]

End of Paper